ANALYSIS REPORT OF POWER PLANT ZELTWEG

THE ANALYSIS REPORT OF A SINGLE POWER PLANT
CONTENT PROPOSAL

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1 INTRODUCTION

Biomass, growing in our forests and on our fields, is one of the major options for future energy supply, offering substantial advantages from the point of view of environmental protection and CO_2-emissions. The additional use of regenerative energy (hydro, wind, solar, biomass) is part of the environmental policy in almost all modern countries. The efforts to increase the share of renewable energy are driven by the danger of global climate change due to CO_2-emission and the aim to decrease the quantity of imported fuels. A reduction of CO_2-emissions can be achieved e.g. by the substitution of fossil fuels like coal by biomass. Similar to other renewable energy resources, agricultural and forestal biomass has, due to its decentralised nature, a considerable potential also in rural areas. As a domestic resource, it offers prospects for sustainable job creation and regional development.

Compared to world-market prices of coal, the energetic use of agricultural and forestal biomass, including residuals from saw mills and wood industries, is no economic advantage. In large parts of Europe only the price of the cheapest biomass fraction "bark" is comparable with the coal price. Therefore, the VERBUND efforts must be seen as a contribution to future technology developments and to international environmental protective activities.

Up to now, two large scale demonstration projects for co-firing of biomass in coal-fired power plants were realised by VERBUND. One at St. Andrä 124 MW_{el} power plant by installing an moving combustion grate integrated at the bottom end of the coal boiler hopper. Another one at Zeltweg 137 MW_{el} power plant, where biomass is gasified in a separate gasification reactor, working on the principle of a circulating fluidised bed. The product gas is led at high temperatures to the coal boiler, where it is burned together with the coal.

Each of these installations is designed for a thermal capacity of 10 MW, replacing approx. 3 % of the coal at standard operation. The relatively small share of biomass yields to a low influence of biomass prices to the total fuel costs of the power plant.

1.1 GENERAL QUESTIONS WITH BIOMASS UTILISATION

Due to the low specific volumetric energy density and the resulting high transport volume, biomass is not suitable for the use as main fuel in centralised large biomass power plants. So first studies dealt with decentralised small power plants of known conventional combustion and conversion techniques. But due to the higher specific investment and personnel costs and the lower efficiency compared to a large power plant, small units have no economical prospects, as shown in Figure 1.

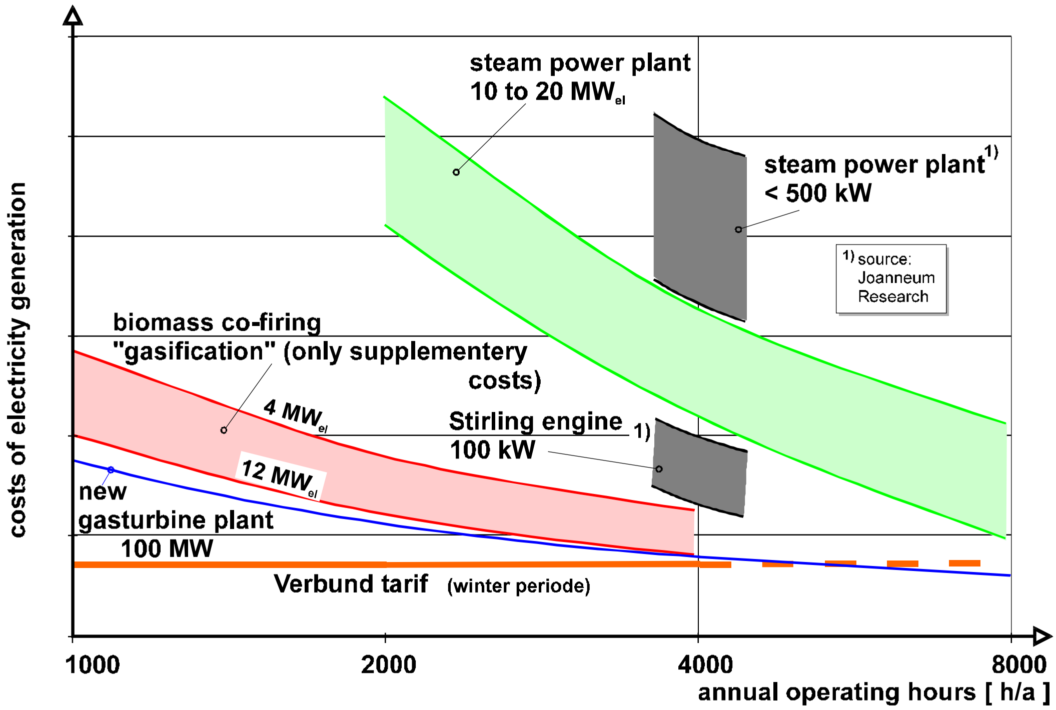

Figure 1: Specific electricity costs of biomass systems

Resulting from the first studies further investigations were concentrated on different options and technologies for co-firing of biomass in large coal-fired power plants. The main advantage of this conception is the benefit of the *economy of scale* in both possible cases of project realisation: For a *new plant installation* the specific investment costs of a large plant are low, so the shared costs of the biomass related parts are low, too. And when a co-firing system is added to an *existing plant*, many parts of the existing structure can be used and this keeps the investment costs low again.

A further positive aspect is, that large units are flexible (within relatively wide limits) to work with different shares of a co-fuel. So the capacity of the co-firing installations can be ideally adapted to the local biomass availability, which is limited not only by a cost optimal transport distance but also by additional CO_2-emissions resulting from the biomass transport.

2 GENERAL INFORMATION

VERBUND-Austrian Hydro Power AG is the biggest Austrian utility for electricity production and meets about 50 % of the electricity demand of Austria.. The group includes the Verbundgesellschaft and subsidiary companies.
A partial privatisation took place in 1988. 49 % of the capital stock are in hand of private investors. 51 % are still publicly hold.

Since the early'80ies *Draukraft*, one of the companies in the VERBUND-group, carried out studies and research projects on biomass recourse potentials and conversion technologies for electricity production from biomass.

Most coal-fired power stations burn pulverised coal. The direct use of biomass, just added to the coal flow, in such firing systems without biomass pre-treatment is not possible, because coal mills are not suitable to grind biomass or biomass chips, like bark, forest residues or chopped wood.

So VERBUND's research activities compared the following concepts of co-firing:

a) combustion of biomass in a separate unit and utilisation of the created heat in the boiler of an existing plant;
b) combustion of biomass on a grate, which is integrated in the furnace of the coal boiler;
c) grinding in special biomass mills and combustion of the pulverised biomass in a coal boiler;
d) gasification (or partial gasification) of biomass and combustion of the product gas as additional fuel in a coal boiler.

At the thermal power plant Zeltweg case d) was realised:
The project holds the abbreviation *BioCoComb*, which is an acronym from the English title: „Preparation of **Bio**fuel for **Co-Comb**ustion in coal-fired power plants".
When biomass is converted into a low calorific value gas by partial or total gasification, this gas can easily be burned in conventional coal boilers. The main advantage of this way of conversion is the higher flexibility in arranging and integrating the main components into existing plants. Whilst other concepts (e.g. a) - c)) have to be placed very near to the combustion chamber, what is unluckily in many cases not possible, a gasifier can also be erected in a distance to the combustion chamber. In the VERBUND demonstration project at Zeltweg for example, the gasifier is outside the boiler house, almost 20 m away from the boiler.

Further advantages of the concept "*BioCoComb*" are, that

a) a low gas quality is sufficient, so no predrying of the biomass is needed,
b) partial gasification is sufficient, resulting in a smaller gasifier design,
c) no gas cleaning or cooling (preventing tar problems) is needed,
d) relatively low temperatures in the gasifier are possible to prevent slagging,
e) favourable effects on power plant emissions (CO_2, NO_x),
f) no severe modifications of the existing coal fired boiler are necessary.

2.1 POWER PLANT ZELTWEG

The Zeltweg thermal power plant was commissioned in 1962. After closing down the nearby coal mine the firing system was converted to hard coal in 1982. Flue gas denitrification takes place by means of the SNCR-process in 1989. After tedious official proceedings a new flue gas desulphurisation plant ("Lurgi Circulating fluidised bed process") was put into operation in 1994. In 1996 the plant was partially automated.
1997 a biomass gasification plant was installed to substitute hard coal by renewables. The gasifier is designed for a firing capacity of 10 MW. Bark, sawdust, wood chips and supplementary fuels are used as fuel. Appr. 3 % of the hard coal can be replaced by biomass.

The power plant is nearly 40 years old and has been in operation for more than 110.000 hours.
At the time it is just operated for peakload energy production.

2.2 SUPPLIERS OF THE MAIN COMPONENTS:

boiler and gasifier manufacturer	Austrian Energy (Waagner Birò)
coal conveying system	MUT
biomass conveying system	Saxlund International
control and instrumentation	Siemens

2.3 STAFF

The number of employees in Zeltweg power plant is 42.

3 PROCESS DESCRIPTION

The technical task was to convert biomass in such a way that it can be burnt in a pulverised coal fired power plant boiler without any problems.
A new conception was pursued and a method was developed with partial gasification and partial combustion. An overall view of the process can be seen in the following Figure 2.

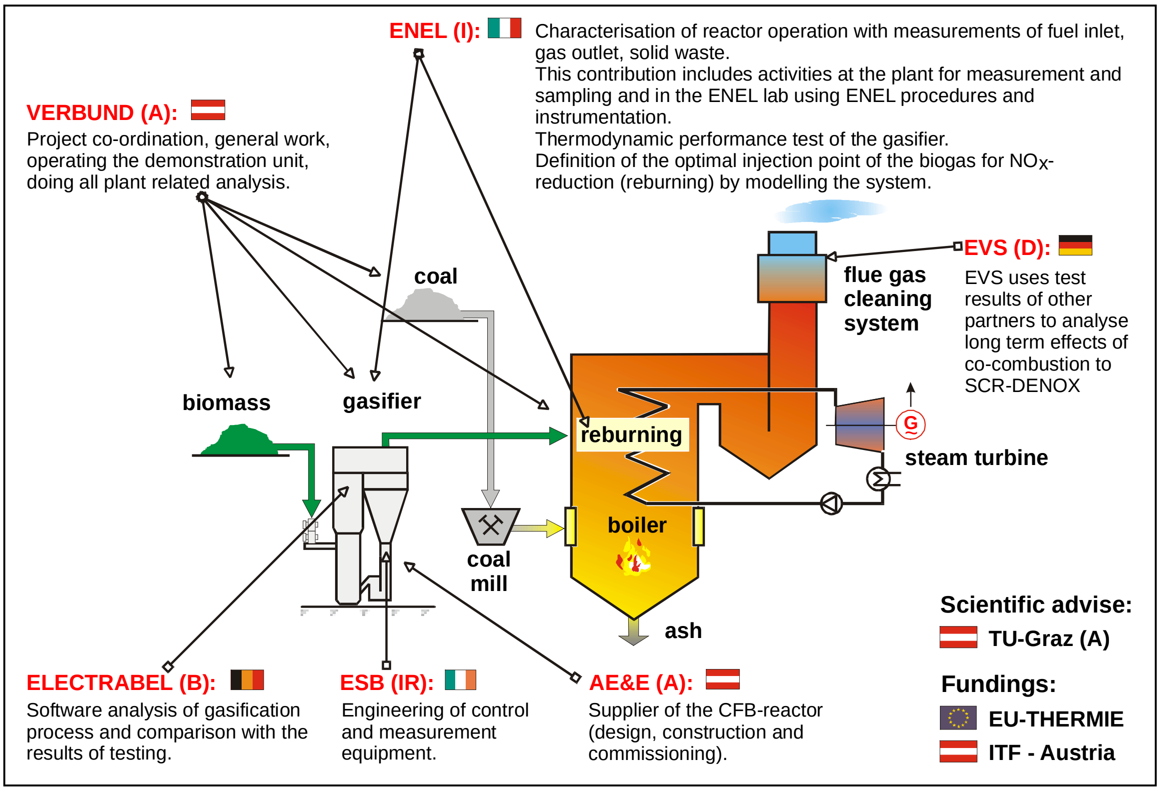

Figure 2: Process Diagram and Partners concerned

The process concept is based on the gasification of biomass in a fluidised bed. In this case, the air is fed to the system to exactly such an extent that part of the fuel burns and while doing so the heat is produced that is required for the gasification of the rest of the biomass, for the combustion of which not enough oxygen is available. Because it is neither a matter of total combustion nor a matter of total gasification it is called „partial gasification". The gas is led uncooled from the gasifier to the boiler where it serves as auxiliary fuel and replaces part of the coal. Apart from the CO_2-reduction, the NO_x-reduction through „reburning" is also of interest.
For integration into the power plant the fluidised bed gasifier is installed near the coal-fired boiler. In the gasifier the biomass is converted to gas which is then directly conveyed to the boiler via a hot-gas-line as a second fuel.

The partial gasification taking place in the reactor is sufficient resp. desired. With this process, pre-drying of the biomass and cleaning of the emerging gas is not necessary. Furthermore, this process can be used to reduce NO_x-emissions, due to the fact that with the aid of the gas a second combustion takes place in the coal-fired boiler.

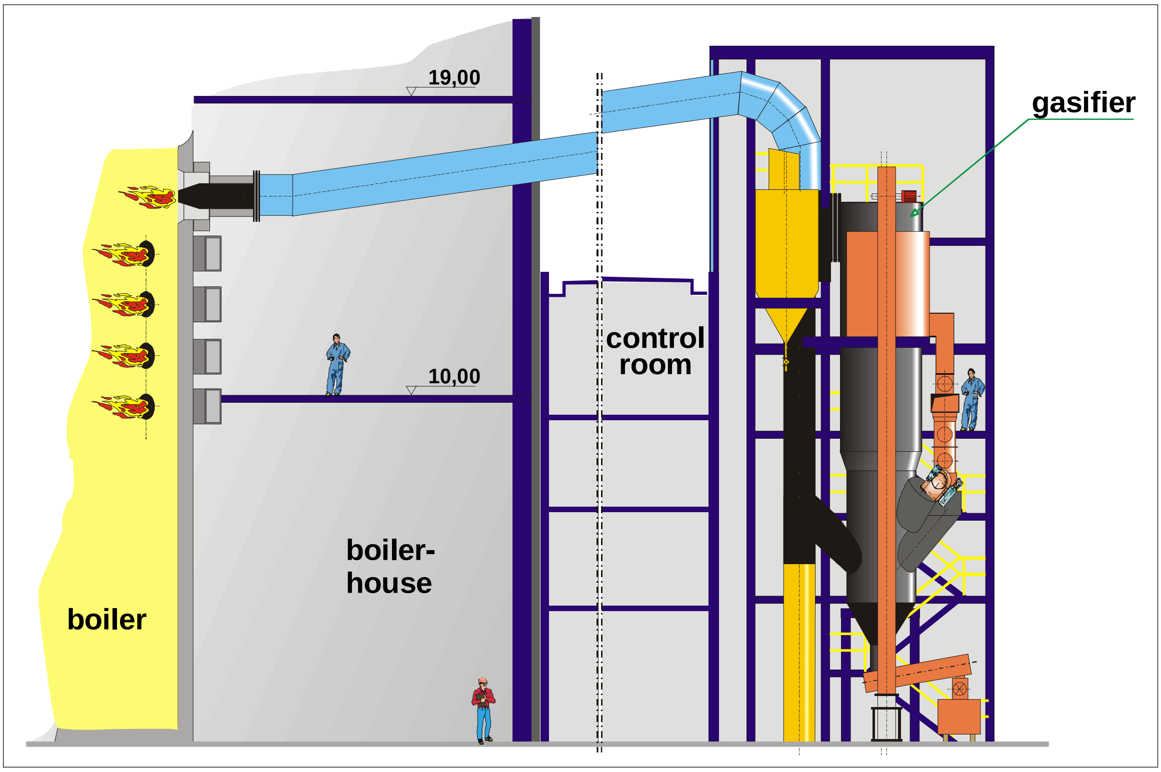

Figure 3: CFB-Gasifier with Boiler House

The designed capacity of the gasifier is 10 MW_{th}, i.e. every hour approx. 16 piled cubic meter of biomass is gasified and the gas is burnt in the coal-fired boiler. The fuels used are mainly bark, wood chips and wood shavings. This way, only locally available fuels are applied, which has positive effects on the agriculture and forestry of the region. With regard to the fuels it is a case of CO_2-neutral, re-growing raw materials, whose application improves the CO_2-balance of energy production.

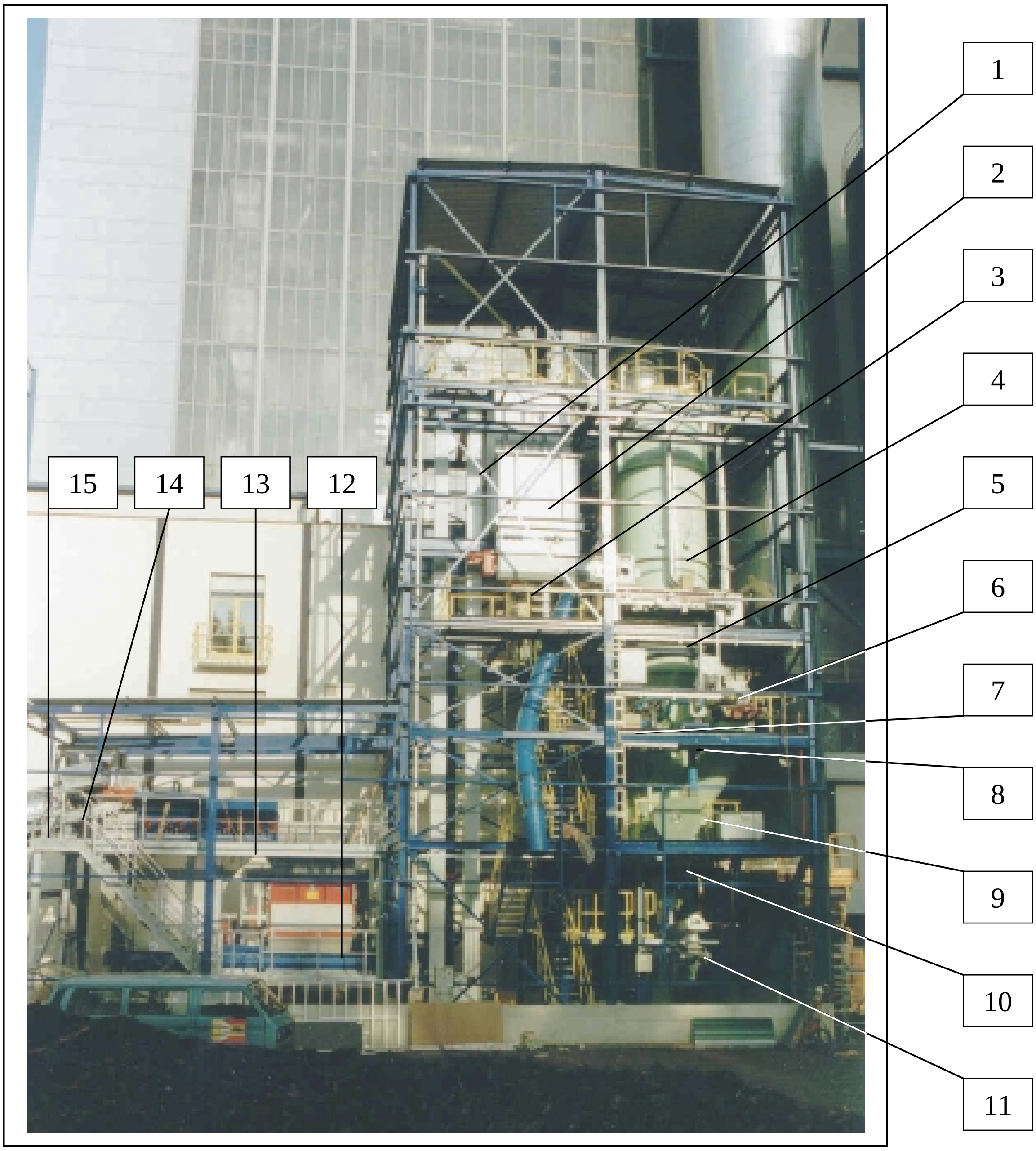

Figure 4: Overall view of the *BioCoComb*-plant

1 ......vertical belt conveyor
2 ..... dosing silo
3 ......dosing screw
4 ..... gasifier
5 ......dosing belt conveyor weigher
6 ..... double rotary feeder
7 ......start oil burner
8 ..... cooling air fan for the start oil burner
9 ......connecting duct between the biomass rotary feeder and the gasifier
10 ....start oil burner primary air fan
11 ... ash discharge screw
12 ....shredder
13 ... disc wheel separator
14 ....magnetic separator
15 ... transverse belt conveyor

3.1 FUEL HANDLING

The coal is delivered by train and then unloaded by an hydraulic wagon tipper. Via a belt conveying system the coal can be delivered directly to the overhead hoppers of the boiler or to the coal storage area. The coal storage area has a capacity of about 500.000 t. With 500.000 t of coal the power plant can be operated about 10.000 hours.
From the storage the coal is delivered by a double line belt conveying system (design capacity 250 t/h per line) to the overhead hoppers of the boiler. Via drag link conveyors (Redler) the coal comes to the roller-mills, where it is grounded to a particle size smaller 200 µm and injected into the boiler.

Trucks bring the biomass (mainly bark and wood chips but also supplementary fuel like railway sleepers, demolition wood, plastics, sewage sludge etc.) to the biomass storage area (capacity about 10.000 pilled cubic meter) of the power plant. By means of wheel-mounted loaders the biomass is fed from the outdoor storage area to a push feeder. The filling of the feeding system is carried out once a day. From there the biomass is transported via a belt conveying system to the gasifier.

The by-products (slag, ash and desulphurisation product) are stabilised in the by-product utilisation plant and deposited at the power plant owned deposit area.

3.2 CONTROL SYSTEM

The coal and biomass feeding system is controlled by a SIMENS TELEPERM ME and Simatic S5 system.

3.3 OPERATING DATA

Table 1: Operating data of the power plant during last 5 years:

		Year	1994	1995	1996	1997	1998
Operating time		(h/a)	1.711	1.184	1.983	1.399	724
Electr. production (brutto		(GWh/a)	186,0	136,0	251,0	165,0	89,0
Electr. production (netto)		(GWh/a)	169,0	123,0	229,0	151,0	81,0
District heating		(GWh/a)	-	-	-	-	-
Fuel	Coal	(t/a)	73.368	45.794	90.033	55.003	28.693
- " -	Lignite	(t/a)	1.720	6.635	-	-	-
- " -	Oil	(t/a)	447	128	417	254	492
- " -	Biomass	(t/a)	-	-	-	355	1.939

4 FUELS AND FUEL PROCUREMENT

The main fuel of the boiler is coal. It is about 97 % of the total fuel consumption. About 3 % is biomass (bark and wood chips). Oil is just used for start up the boiler.

The average moisture content of the biomass has been about 50 % and the net calorific value about 8.000 kJ/kg. The average price of the biomass is about 7 EURO/MWh.

Table 2: Main fuels for St. Andrä power plant

	Coal	Biomass
Fuel demand (t/h)	47	5
C (%)	48 – 80	20
N (%)	< 1,8	0,2
S (%)	< 4,0	0,0
Ash (%)	< 25,0	1,2
H_2O (%)	< 15,0	20 – 70
Hu (MJ/kg)	19 - 30	6 - 16

4.1 ANNUAL USE OF DIFFERENT FUELS

The annual use of different fuels during the last five years (1994 – 1998) can be seen in the Table on page 11 (Operating data).

The coal is mainly “Polish Bituminous Coal”. But the firing system is designed for coal from all over the world.

The biomass is bought from the region forest industries. The price is based on the energy content. It is delivered by truck. Supplementary fuel comes also from the region to avoid long transport distances.

5 FUEL HANDLING AND FEEDING SYSTEM

The following figure shows an overall view of the equipment for fuel supply. By means of wheel-mounted loaders the biomass is fed from the outdoor storage area to a push feeder which has a capacity of 500 m^3. This equals a daily demand for the gasifier. The filling of the push feeder is carried out once a day. From there the biomass is conveyed via a conveying system to the 20 m^3 dosing silo. A metal separator and a shredder are installed along the conveying route before the dosing silo. The required quantity of biomass (see Diagram 1) is fed from the dosing silo via a dosing screw, a belt conveyor weigher and via a double rotary feeder to the gasifier.

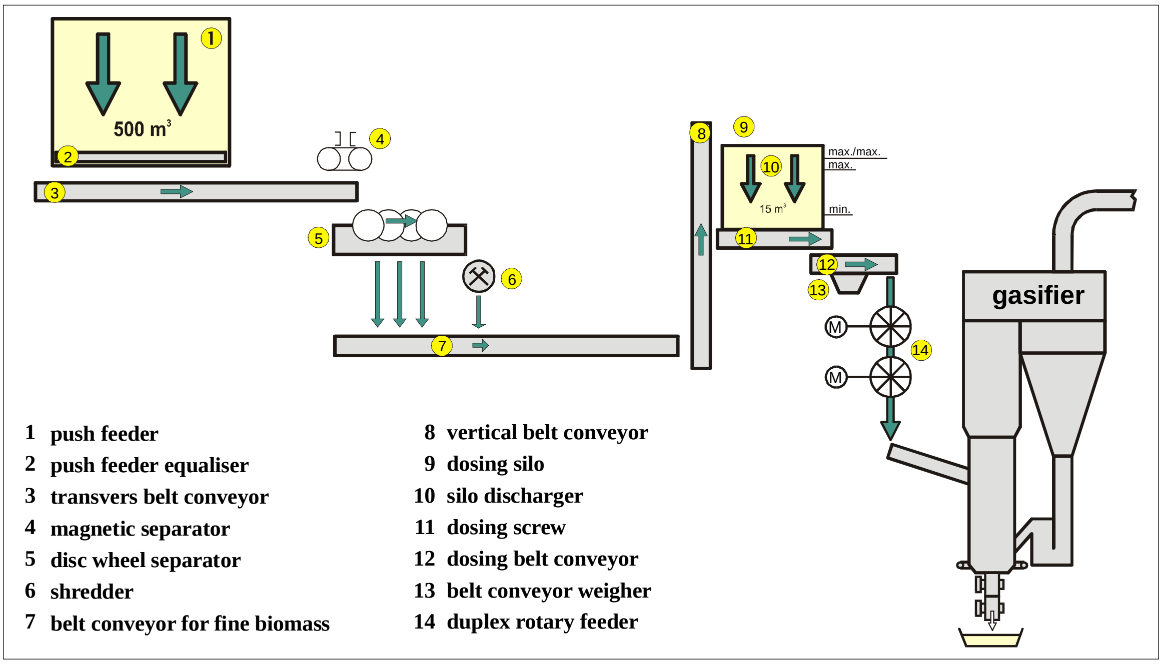

Figure 5: Flow Chart of the Biomass Conveying System

The design for fuel supply assumed that the biomass is delivered mainly in the required particle size with a low proportion of oversize particles. These oversize particles, comprising individual pieces of up to 100 cm length, are cut to the required size in the in-line installed shredder.
The feeding of biomass into the gasifier is carried out via a double rotary feeder. This serves mainly to seal the slightly over pressured gasifier from the atmosphere.

The capacity of the conveying system is about 25 m³/h.

5.1 FUEL RECEIVING

The biomass (mainly bark and wood chips) is delivered by truck. The outdoor fuel storage pile for the heating period (the power plant is just operating in the winter time – peakload) is filled mainly in autumn. Supplementary fuels like demolition wood, railway sleepers, plastics etc. are delivered “just in time”.
From the unloading station the fuels are stored by means of wheel loaders. Because of the fuel composition there are no problems with dust emission during unloading the biomass.
From the pile once a day biomass is brought to the push feeder, where the fully automatic fuel conveying line starts.
When using a mixture of biomass and supplementary fuels for co-combustion this can be realised automatically at the push feeder. The push feeder is divided into two sections. One section can be controlled independent from the other. So it is possible to produce different mixtures from biomass and supplementary fuel.

5.2 SCREENING AND CRUSHING

The design for fuel supply assumed that the biomass is delivered mainly in the required particle size with a low proportion of oversize particles. These oversize particles, comprising individual pieces of up to 100 cm length, are cut to the required size in the in-line installed shredder.
To separate the oversize particles a disc wheel separator is installed in the conveying line. The disc wheel separator has a construction length of 3.400 mm. 16 wheels, each with 10 discs of normal structural steel, are installed. Each wheel has its own direct drive with automatic reverse control to prevent blockages. Particles that are small enough to be gasified go directly to the downstream belt conveyor for "fine" biomass. Oversize particles are cut to the required size in the in-line installed crusher.
The crusher was delivered by the Austrian supplier "Lindner RecyclingTech". The type is "Micromat MS 2000" (see the following photograph).

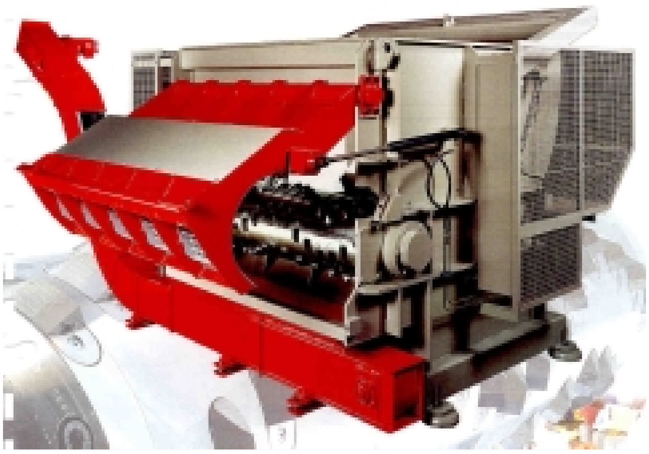

Photo 1: The inline installed shredder

The crusher is designed as a one rotor crusher with automatic reversing arrangement. The rotor length is 2.000 mm. The rotor speed is 85 min^{-1}. The rotor has 108 carbide cutting tips that can be used four times. The cutting tips are of a special type of hardened steel. To guarantee the cutting size a drum screen (∅ 50 mm) is installed. The capacity of the crusher is 20 – 50 m^3/h. In order to protect the crusher a magnetic separator is installed upstream the disc wheel separator.

Problems:
The discs of the disc-wheel-separator were designed asymmetrical as shown on the left side of the following figure. With this asymmetrical form it might happen that, because of the changing clearance between wheel and disc during rotation (min./max.), biomass blocked the wheels and the conveyor stopped operation.

Normally it was possible to get the disc-wheel-separator into operation again by using the reverse mode manually. This manipulation takes about 20 minutes and sometimes it was necessary to switch from gasification to combustion mode to keep the *BioCoComb* plant in operation.

Solution:
At first the automatic reverse-controlling was optimised. This modification showed not the expected success. Then the discs were changed as shown on the right side of the following figure. From that time the disc-wheel-separator worked without any problems. In case that a piece of wood blocked a wheel it became free by using the automatic reverse-control.

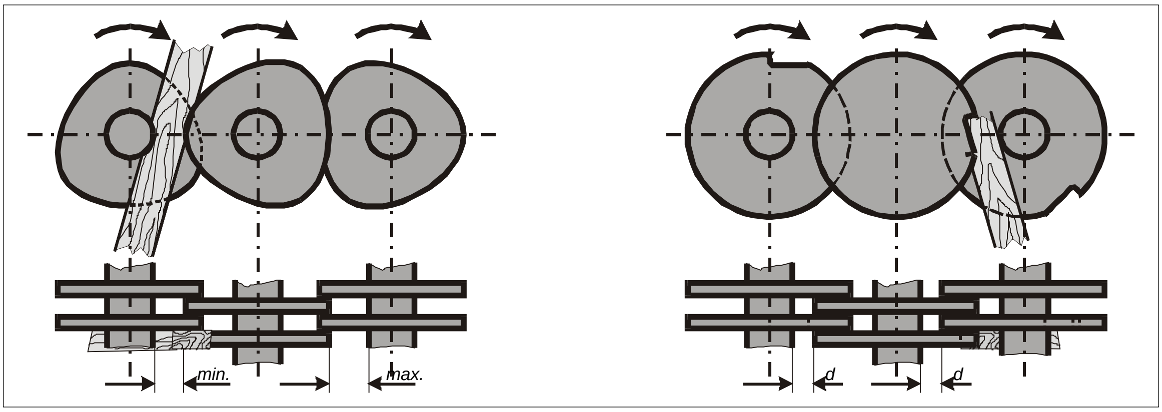

Figure 6: Design of the Disc-Wheel-Separator

5.3 CONVEYORS

The conveying system of the *BioCoComb* plant is designed as shown in the flow chart on page 12 (fuel handling and feeding system).
The substantial parts of the conveying system are:
- push feeder (500 m³ - this equals a daily demand for the gasifier)
- push feeder equaliser and vibration conveyor (to even out the discontinuous output of the push feeder)
- transverse belt conveyor
- magnetic separator
- disc wheel separator
- crusher
- belt conveyor for “fine” biomass
- vertical belt conveyor (elevator)
- dosing silo (20 m³) with the silo discharger (also designed as a push feeder)
- dosing screw
- dosing belt conveyor weigher
- duplex rotary feeder.

The belt material is steelcord and special resistant against the aggressive contents of the biomass.
Each belt conveyor is adapted with a belt cleaning system (hard metal), a belt tension adjusting system, speed controllers, mechanical blockage guards at dropping sites and with emergency switching equipment.
Every chute has a overflow safety device.

The disc wheel separator, the crusher, the belt conveyor weigher and the double rotary feeder have their own monitoring systems which is integrated to the control system of the conveying line.
Upstream the push feeder a push feeder equaliser (a rotor with a diameter of 500 mm and a length of 12 m) and a vibration conveyor are installed. That makes sure, that the following conveying system will not be overfilled.

Problems with conveyors:

- **Transverse belt conveyor**

Problem:
The transverse belt conveyor was designed with an angle of inclination of about 14 degree. When the humidity of the biomass was greater than 50 % wt. and the outside air temperature was below minus 2 degree Celsius the biomass often slided back. In that case the conveying system stopped and it had to be cleaned. It was necessary to start the system manually for a few minutes to warm up the conveying belt. Then it was possible to start the system again in automatic mode. Because the manipulation time for cleaning and warming took about two hours, the *BioCoComb*-plant had to be switched from gasification to combustion to keep it in operation (the size of the dosing silo is designed for about one hour in gasification mode – 15 m³; that refers to fife hours in combustion mode).

Solution:
In a first step the angle of inclination was reduced to about 13,5 degrees. But it was also decided to keep the transverse belt conveyor in operation whenever the outside air temperature was below minus 5 degrees Celsius. This was implemented in the control system of the conveying system and it works automatically.

- **Vertical belt conveyor**

Problem:
The vertical belt conveyor often tilted. The problem was caused by the configuration between the upstream situated belt conveyor and the vertical belt conveyor, the lower drum (see the following Photos) of the vertical belt conveyor and the speed of the belt. The feeding chute of the vertical belt conveyor often had to be cleaned by hand.

Solution:
The situation between the before situated belt conveyor and the vertical belt conveyor was modified in three steps. The lower drum of the vertical belt conveyor was modified, the speed of the belt was reduced and belt guide rolls

where installed.
From that time the vertical belt conveyor worked satisfying.

Photo 2: Problems at the Vertical Belt Conveyor

- **Dosing silo**

Problem:
The biomass in the dosing silo often built a bridge and it was not possible to get the biomass automatically out of the silo.
Solution:
Baffle plates were installed in the dosing silo and the adapter to the following dosing screw was modified with a special slippery synthetic material.

- **Dosing belt conveyor weigher**

Problem:
Because of the inconstant delivery of biomass from the screw between the dosing silo and the dosing belt conveyor weigher and because of different quality of the biofuel (density) the dosing belt conveyor worked not satisfying. The biomass input into the gasifier changed in a very wide range (2.000 to 5.000 kg/h), so that the gasifier often switched from gasification- to combustion-mode because the biomass flow drops under the lower limit.
Solution:
The screw before the dosing belt conveyor was connected via the control system with the dosing belt conveyor so that it became a “dosing screw”. The internal software of the dosing belt conveyor was modified.

• **Biomass rotary feeders**
Problem:
Bigger biomass fractions (up to 100 mm in one dimension) often blocked the rotary feeders. In case that the rotary feeder reverses more than three times (internal control system) the gasifier is switching from gasification- to combustion-mode. That happened several times.
Solution:
Baffle plates at the inlet of the rotary feeders were installed and the reverse control system was optimised. This modifications showed not the expected success. Because it was not possible to install bigger rotary feeders it was necessary to modify the disc wheel separator to obtain finer particle sizes. The distance between the discs had to be reduced, so that the particle size is finer.
From that time the rotary feeders were working satisfying.

5.4 STORAGE

In order to store the fuel an outdoor storage place was prepared with a max. storage capacity of 10.000 piled cubic meter, which corresponds to almost a month's supply. The fuel stocks mainly comprise bark, the outdoor storage of which is unproblematic. Wood chips, especially wood shavings and all supplementary fuels are less resp. hardly suitable for outdoor storage and for this reason have delivery periods at short notice according to demand.
The fuel storage area is sealed for ground water protection and has subsurface drainage. This way it is ensured that rain water does not penetrate into the ground water from the biomass pile. The accumulating surface waters are collected in a storage basin where they are further treated in accordance with the official directives.

Caused by biochemical reactions during long storage the temperature in a large biomass pile increases and this entails danger of self-ignition. To prevent such fire accidents, the pile must be compacted with heavy wheel loaders, which have to have access to the pile from all sides (larger storing place).

Besides the danger of fires, the energetic losses from biochemical processes in the pile reach 15% p.a. The storing behaviour and the conversion processes in the biomass were investigated during a long term test from the Technical University of Graz.

5.5 BOILER FEEDING

The feeding of biomass into the gasifier is carried out via a double rotary feeder. This serves mainly to seal the slightly over pressured gasifier from the atmosphere. The lower rotary feeder is cooled with water to avoid thermal stress. The upper rotary feeder is rinsed with compressed air in order to rule out a possible CO-slip. The purge air is led to the gasifier.

Hot gas duct:

The hot gas duct connects the gasifier with the coal-fired boiler and has the task to conduct the light gas produced in the biomass gasifier to the coal-fired boiler for combustion with the lowest possible heat loss.

Gas injection point in the coal fired boiler:

The light gas produced in the gasifier is injected into the boiler at one single point. The burn-out period for the charcoal in the furnace of the coal-fired boiler and the best possible „reburning effect“ were significant calculation parameters.
In order to achieve the best possible distribution of the gas in the furnace of the coal-fired boiler the hot gas duct at the injection point was designed in the form of a nozzle. In this area the diameter is decreased from 750 to 600 mm. Seeing that the nozzle is not brick lined, it is cooled by air.

5.6 ASH HANDLING

A discharge device for ash and for the foreign matter that accumulates in the gasifier (e.g. nails, small pieces of metal, stones etc.) is installed underneath the gasifier. Ash discharge is carried out intermittently – depending on the pressure drop in the fluidised bed – via a cooled screw and a cellular wheel.
The dimensions are sufficient also to discharge larger particles, so no blockages of the discharge system were observed.

Boiler Ash:

The bottom ash from the coal falls into a wet slag conveyor. The wet slag conveyor feeds extinguished slag into a container. This container is unloaded once a day at the ash storage which is part of the power plant area. The slag quantity is about 500 kg/h.
Fly ash which is separated in a pre-electric precipitator (before the desulphurisation plant) is conveyed into a fly ash bunker by pneumatic conveyors. The desulphurisation product (a is a mixture of fly ash of coal firing, and desulphurisation product) which is separated in an electric precipitator is conveyed into a desulphurisation product bunker by pneumatic conveyors. In the “by-product utilisation plant” these two products are mixed and stabilised in a defined mixing ratio. The stabilised by-products were deposited at the power plant owned deposit area.

The quantity of by-products is about 3.000 kg/h.

6 CONTROL SYSTEM

The Siemens Company supplied the automation technology (System TELEPERM ME). Regarding that this company also supplied the control and instrumentation for the power plant unit, it was possible to link the gasifier control and instrumentation system (SIMATIC S5) to the existing control system via a bus system.
The gasification plant is completely automated. The gasifier can only be started up if certain criteria on the part of the coal-fired boiler are fulfilled (stable coal fire). The gasifier protection system is directly linked with the boiler protection system. In the case of a violation of the protection criteria the gasification plant is automatically switched off.
Operating and monitoring of the *BioCoComb*-plant is carried out via the existing control system (Siemens OS 520), which was extended for this reason by one operator terminal. All relevant data of the plant can be seen at this operator terminal in four pictures.
All measurements necessitated for operating the gasification plant (pressures, temperatures, quantities etc.) are recorded and stored in a data acquisition system.

The biomass conveying and treatment plant is operated as an independent island of automation (SIMATIC S5). The plant can only be started up resp. shut down from the main control centre (control-room).
The proportioned feeding of biomass into the gasifier, starting at the dosing silo, is linked with the control and instrumentation system of the gasifier (open-loop and closed-loop control system).
During the hot commissioning phase extensive tests of the plant with combustion operation were carried out. From the very first start there were no problems with changing from combustion to gasification. Even the change-over from gasification to combustion operation took a normal course. Within a week it was possible to define the corresponding process engineering connections empirically, to integrate them into the control and monitoring system and to automate them.

7 INVESTMENT AND MAINTENANCE (COSTS) AND USABILITY

The power plant Zeltweg was commissioned in 1962. Based on 1995 the replacement costs (calculated from the investment costs) are about 305 Mio Euro. The maintenance costs are around 1,85 Mio. Euro per year.

The total costs for the *BioCoComb* project (engineering, biomass storage, conveying system, gasifier, connection to the coal boiler, commissioning and monitoring) were about 5,1 Mio. Euro.
Assuming that the same project (10 MW_{th}) will be replicated the total (investment) costs will be in the order of 3,7 Mio Euro. These costs include the preparation of the technical specifications, the tenders, the erection of the whole installation and the commissioning.

For a commercial version of the project (100 MW_{th}) the total (investment) costs will be in the range of 10 to 14,5 Mio Euro.
A study for a commercial version of the project (100 MW_{th}) for one of the Austrian thermal power plants will be worked out from VERBUND at the time.

The gasification plant can be seen as a fuel preparation unit, that is operating always together with the thermal power plant and that is substituting a part of the coal. The system operates in an almost fully automated mode, so the main personal costs are for feeding of the biofuel system only. Regarding that the gasifier substitutes 3% of the coal this portion of the man-power from the coal supply is available and sufficient for the biofuel supply, so no extra costs are caused.

All other operating costs of the gasifier have to be considered as additional operating costs of the complete system. The averaged additional costs of all operation and maintenance activities of the gasifier during the so far reached operating time are 0,17 Cent/kWh_{therm} or 17 EURO/operating hour at standard load of 10 MW_{therm}.

8 REMARKS

After two demonstration periods the project can be referred to as very successful. The plant achieves stable operation with various fuels (bark, wood shavings, wood chips and also supplementary fuels) and shows an elastic behaviour regarding load changes and also what the change of fuel quality concerns, which is unavoidable in the case of biomass. Not only the ignition and gasification behaviour of the biomass in the gasifier fulfil all expectations but also the combustion behaviour of the gas in the boiler. The process-engineering critical change-over from combustion to gasification mode and vice-versa happens gently, only with a slight temperature increase within tolerable limits. The quality of the gas is well-suited for co-combustion in the boiler.

Comparing with the project aims, defined in the EU-proposal, it can be stated that the main aim, the demonstration of a successful technology, is totally reached. But also the other aims

- CO_2-reduction by using renewables replacing fossil fuels (coal)
- Monitoring long-term influences of biomass co-combustion on boiler performance
- Monitoring other additional effects (e.g. NO_x-reduction)

could be fulfilled.

Modifications to the planned systems had to be elaborated mainly in the conveying system. The control system of the plant was developed for this application the first time, so there were some major changes during the system layout period and during hot commissioning, that finally resulted in a satisfying solution.
Besides the technical aspects also the economics are very important. Of course it is not possible to reach full economical competitiveness compared with fossil fuels at the actual low prices for the fossil fuels. But if one keeps in mind that the target is to reduce CO_2-emissions by substituting coal by renewables, the costs have to be compared not with the fossil fuel technologies, but with other alternatives for electricity production for renewables. On the other hand it is always challenging to fulfil all economic targets with a first demonstration unit of a new plant size.

9 APPENDICES

Appendix 1: Basic Data of the thermal power plant Zeltweg
Appendix 2: Technical description of the thermal power plant Zeltweg
Appendix 3: Layout drawing of the biomass conveying system